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(54) **High-speed scanning arrangement**

Abtastanordnung mit hoher Geschwindigkeit

Dispositif d'exploration à grande vitesse

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates, in general, to a scanner which is operative for repetitively scanning indicia having parts of different light reflectivity; for example, such as bar code symbol, and more particularly pertains to the operation of a scanning arrangement of that type at high scanning speeds in two-dimensional or multi-axes scan patterns.

Moreover, the invention is specifically directed to the provision of a fast two-dimensional scanning scan element adapted to operate at higher frequencies and which is subjected to lower stresses during respective scanning of indicia on a target object, in comparison with scanning arrangements of this type which are currently employed in the technology, thereby maximizing the efficiency of the scan element by enabling operation thereof at larger amplitudes and increased dimensions for the scan element or mirror.

The utilization of laser scanning devices for the scanning or reading of information provided on a target; such as a package or sale item, is well known in this particular technology and has found wide acceptance in commerce. In this connection, various types of laser scanning devices incorporate scanning heads which house optical reading systems, such as bar code readers, for the reading of information or bar code symbols on targets which are scanned by a laser beam projected from the bar code reader. In general, such laser scanning devices; especially those in the type of bar code readers, are widely employed in industry, such as manufacturing, shipping, and in retail commerce and, for example, may be permanently incorporated in the structures of check-out counters of supermarkets, whereby the items of merchandise having the bar code symbols imprinted thereon or applied thereto are passed over a fixed bar code reader located beneath the counter surface so as to provide a record for the merchant of the merchandise being purchased by a consumer, and concurrently a readout (and possibly a printed record) for the consumer.

Alternatively, the bar code reader or laser scanning device may also be constituted of an optical scanner unit which is fixedly mounted on a stand extending above a support platform or countertop on which the merchandise may be arranged; or in many instances of utilization, pursuant to a preferred embodiment of the invention, may be in the form of a miniature, lightweight and gun-shaped device having a pistol grip, and which the actived device is normally passed over the bar code symbol which is imprinted on a sale item or target at some short distance therefrom so as to enable scanning of the information provided by the bar code symbols.

2. Discussion of the Prior Art

Various optical readers and optical scanning systems have been developed heretofore for reading bar code symbols appearing on a label or on the surface of an article. The bar code symbol itself is a coded pattern of indicia comprises of a series of bars of various widths spaced apart from one another to bound spaces of various widths, the bars and spaces having different light-reflecting characteristics. The readers and scanning systems electro-optically transform the graphic indicia into electrical signals, which are decoded into alphanumerical characters that are intended to be descriptive of the article or some characteristic thereof. Such characters are typically represented in digital form and utilized as an input to a data processing system for applications, in point-of-sale processing, inventory control, and the like. Scanning systems of this general type have been disclosed, for example, in U. S. Patent Nos. 4,251,798; 4,369,361; 4,387,297; 4,409,470; 4,760,248; and 4,896,026, all of which have been assigned to the same assignee as the instant application.

As disclosed in some of the above patents, one embodiment of such a scanning system resides, inter alia, in a hand-held, portable laser scanning head supported by a user, which is configured to allow the user to aim the head, and more particularly, the light beam or laser beam projected therefrom, at a target and a symbol which is to be read.

The light source in a laser scanner is typically a gas laser or semiconductor laser. The use of semiconductor devices, such as a laser diode, as the light source in scanning systems is especially desirable because of their small size, low cost and low power requirements. The laser beam is optically modified, typically by a lens, to form a beam spot of a certain size at the target distance. It is preferred that the beam spot size at the target distance be approximately the same as the minimum width between regions of different light reflectivity, i.e., the bars and spaces of the symbol.

Bar code symbols are formed from bars or elements that are typically rectangular in shape with a variety of possible widths. The specific arrangement of elements defines the character represented according to a set of rules and definitions specified by the code or "symbology" used. The relative size of the bars and spaces is determined by the type of coding used, as is the actual size of the bars and spaces. The number of characters per inch represented by the bar code symbol is referred to as the density of the symbol. To encode a desired sequence of characters, a collection of element arrangements are concatenated together to form the complete bar code symbol, with each character of the message being represented by its own corresponding group of elements. In some symbologies a unique "start" and "stop" character is used to indicate where the bar code begins and ends. A number of different bar code symbologies exist. These symbologies include UPC/EAN,

Code 39, Code 128, Codabar, and Interleaved 2 of 5.

For purpose of discussion, characters recognized and defined by a symbology shall be referred to as legitimate characters, while characters not recognized and defined by that symbology are referred to as illegitimate characters. Thus, an arrangement of elements not decodable by a given symbology corresponds to an illegitimate character(s) for that symbology.

In order to increase the amount of data that can be represented or stored on a given amount of surface area, several new bar code symbologies have recently been developed. One of these new code standards, Code 49, introduces a "two-dimensional" concept by stacking rows of characters vertically instead of extending the bars horizontally. That is, there are several rows of bar and space patterns, instead of only one row. The structure of Code 49 is described in U. S. Patent No. 4,794,239.

A one-dimensional single-line scan, as ordinarily provided by hand-held readers, has disadvantages in reading these two dimensional bar codes; that is, the reader must be aimed at each row, individually. Likewise, the multiple-scan-line readers produce a number of scan lines at an angle to one another so these are not suitable for recognizing a Code 49 type of two-dimensional symbols.

In the scanning systems known in the art, the light beam is directed by a lens or similar optical components along a light path toward a target that includes a bar code symbol on the surface. The scanning functions by repetitively scanning the light beam in a line or series of lines across the symbol. The scanning component may incorporate a drive or scanning motor adopted to either sweep the beam spot across the symbol and trace a scan line across and past the symbol in a high-speed repetitive mode, or scan the field of view of the scanner, or do both.

Scanning systems also normally include a sensor or photodetector which functions to detect light reflected from the symbol. The photodetector is therefore positioned in the scanner or in an optical path in which it has a field of view which extends across and slightly past the symbol. A portion of the reflected light which is reflected off the symbol is detected and converted into an electrical signal, and electronic circuitry or software decodes the electrical signal into a digital representation of the data represented by the symbol that has been scanned. For example, the analog electrical signal from the photodetector may typically be converted into a pulse width modulated digital signal, with the widths corresponding to the physical widths of the bars and spaces. Such a signal is then decoded according to the specific symbology into a binary representation of the data encoded in the symbol, and to the alphanumeric characters so represented.

The decoding process in known scanning systems usually work in the following way. The decoder receives the pulse width modulated digital signal from the scanner, and an algorithm implemented in software attempts to decode the scan. If the start and stop characters and the characters between them in the scan were decoded successfully and completely, the decoding process terminates and an indicator of a successful read (such as a green light and/or an audible beep) is provided to the user. Otherwise, the decoder receives the next scan, performs another decode attempt on that scan, and so on, until a completely decoded scan is achieved or no more scans are available.

Such a signal is then decoded according to the specific symbology into a binary representation of the data encoded in the symbol, and to the alphanumeric characters so represented.

Laser scanners are not the only type of optical instrument capable of reading bar code symbols. Another type of bar code reader is one which incorporates detectors based upon charge coupled device (CCD) technology. In such readers, the size of the detector is larger than or substantially the same as the symbol which is to be read. The entire symbol is flooded with light from the reader, and each CCD cell is sequentially read out to determine the presence of a bar or a space. Such readers are lightweight and easy to use, but require substantially direct contact or placement of the reader on the symbol to enable the symbol to properly read.

Such physical contact of the reader with the symbol is a preferred mode of operation for some applications, or as a matter of personal preference by the user.

Further, attention is drawn to EP-A-0 425 844 which shows a power saving scanning arrangement including a light reflector, which is fixedly mounted on an elongated torsion wire, which is secured to an E-frame. The torsion wire can be twisted via a trigger in order to cause the wire and the light reflector to oscillate around an axis of rotation.

SUMMARY OF THE INVENTION

The invention is directed towards a scanner as defined in claims 1 to 19 and a method for reading indicia as defined in claims 20 to 37.

Accordingly, it is an object of the present invention to provide a scan element, such as a mirror, which is uniquely dimensioned and mounted on a holder of oscillation-imparting component such that the center of mass of the mirror essentially coincides with the fast axis of oscillatory rotation thereof, to resultingly reduce stresses in the support structure thereof.

Another object of the present invention resides in the provision of a scanning arrangement of the type described herein, which includes a resonance asymmetric scan element comprising a scan mirror dimensioned and mounted for oscillation in such a manner that the center of mass thereof essentially coincides with the fast or high-frequency axis of rotation of the scan element.

Yet another object of the present invention relates to a novel method of utilizing the asymmetric resonance

scan element pursuant to the invention as described hereinabove so as to substantially reduce vibratory stresses which are generated during high-frequency operation in the course of implementing a fast two-dimensional scanning pattern.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference may now be had to the following detailed description of exemplary embodiments of the invention, taken in conjunction with the accompanying drawings; in which:

Figure 1 illustrates a longitudinal sectional view through an exemplary embodiment of a laser scanning device incorporating the inventive resonance asymmetric scan element, wherein the scanning device is in the shape of a hand-held gun-shaped component;
Figure 2 illustrates a cross-sectional view through a typical scanning arrangement;
Figure 3 illustrates generally diagrammatically a portion of a scanning arrangement constructed pursuant to the prior art;
Figure 4 illustrates a further embodiment of a scanning arrangement constructed pursuant to the prior art;
Figure 5 illustrates, in respectively cross-sectional and front views, a scanning arrangement pursuant to the invention;
Figure 6 illustrates, on an enlarged scale, a front perspective view of a holder for mounting the scan element or mirror of the scanning arrangement of Figs. 5a and 5b;
Figure 7 illustrates, in a perspective view, the holder pursuant to Fig. 6 with the scan mirror mounted thereon;
Figures 8a through 8c illustrate, in diagrammatic end views, various stages during the introduction of the scan mirror into the inventive holder;
Figure 9 illustrates, generally diagrammatically, the mounting of the mirror or scan element in the holder of Figs. 6 and 7;
Figure 10 is a front perspective view of another embodiment of the scanning arrangement;
Figure 11 is a rear perspective view of the scanning arrangement of Fig. 10;
Figure 12 is a generally diagrammatic side view of the scanning arrangement of Figs. 10 and 11; and
Figure 13 is a sectional view taken along line 13 - 13 in Fig. 12.

DETAILED DESCRIPTION

Referring in more specific detail to the drawings, as diagrammatically illustrated in Figure 1, pursuant to a typical exemplary embodiment, a laser scanning device may be a bar code reader unit 100 in a hand-held gun-shaped configuration, although obviously other kinds of configurations of scanners readily lend themselves to the invention, having a pistol-grip type of handle 153 and in which a movable trigger 154 is employed to allow the user to activate the light beam 151 and detector circuitry when pointed at the symbol to be read, thereby saving battery life if the unit is self-powered. A lightweight plastic housing 155 contains the laser light source, the detector 158, the optics and signal processing circuitry, and the CPU 140 as well as power source or battery 162. A light-transmissive window 156 in the front end of the housing 155 allows the outgoing light beam 151 to exit and the incoming reflected light 152 to enter. The reader 100 is designed to be aimed at a bar code symbol by the user from a position in which the reader 100 is spaced from the symbol, i.e., not touching the symbol or moving across the symbol. Typically, this type of hand-held bar code reader is specified to operate in the range of from contact with the symbol to distances of perhaps several inches or even further therefrom.

As further depicted in Figure 1, a suitable lens 157 (or multiple lens system) may be used to focus the scanned beam into the bar code symbol at an appropriate reference plane. A light source 146, such as a semiconductor laser diode, is positioned to introduce a light beam into the axis of the lens 157, and the beam passes through a partially-silvered mirror 147 and other lenses or beam-shaping structure as needed, along with an oscillating mirror or scanning element 159 which is attached to a scanning motor 160 activated when the trigger 154 is pulled. If the light produced by the source 146 is not visible, an aiming light, if needed, produces a visible-light spot which may be fixed, or scanned just like the laser beam; the user employs this visible light to aim the reader unit at the symbol before pulling the trigger 154.

As is illustrated in Fig. 2 of the drawings, which represents a typical scanning arrangement 200 for the implementation of a two-dimensional or two-axis scan pattern, a holder 202 incorporates a U-shaped spring 204 having a pair of arms 206 and 208. A scan element 210; for example, such as a light reflector or mirror, is fixedly mounted at the free end of the arm 208, while a permanent magnet 212 is mounted at the opposite free end of arm 206. An electromagnetic coil 214 is fixedly mounted on an upright support member 216, the latter of which is secured to a base 218. Electrical input leads 220 supply an energizing signal to the electromagnetic coil 214. The arm 206 and the permanent magnet 212 are secured to a generally planar spring member 222 at one end 222a thereof, and which has its other end 222b secured to the base 218. The planar spring 222 may be made of any suitable flexible material, such as a leaf spring, a flexible metal foil, a flat bar. The holder comprising the U-shaped spring structure 204, 206, 208 may also be constituted from any suitable metallic material possessing resilient or flexibility properties; preferably a material such as a beryllium-copper alloy. The mass of

the mirror 210, which may be equal to the mass of the permanent magnet 212, under certain instances may be much higher than the equivalent mass of the U-shaped spring 204.

Under circumstances, it may be desirable to scan indicia with a raster-type scan pattern, whereby in such a scan pattern, a series of substantially horizontal and substantially parallel scan lines are traversed from an upper horizontal scan line, proceeding downwardly with a multiplicity of intermediate horizontal scan lines to a lower horizontal scan line in order to uniformly cover the desired scan area. In order to obtain a raster-type scan pattern, the U-shaped spring 204 and the planar spring 222 may be arranged to vibrate in planes which are orthogonal to each other. As shown in the drawing, the arms of the U-shaped spring 204 will vibrate in the X-Z plane and the planar spring 222 will vibrate in the X-Y plane. Through this arrangement of the holder structure 202, the mirror or scanner component 210 is mounted for angular oscillating movement, in first and second alternate circumferential directions, between first and second pairs of scan end positions. Moreover, due to their respective shapes and positioning, the U-shaped spring 204 will vibrate within a high range of frequencies, typically of within 200 to 800 Hz, whereas the planar spring 222 will vibrate within a low range of frequencies, typically about 50 to 200 Hz. The amplitude of vibration necessary to scan the symbol will depend upon the size of the symbol and would typically be at least 10 to 30° optical. In order to increase the angular amplitude by the scan line produced by the holder arrangement 202, which may be desirable for certain applications, such an increase in angular amplitude may be readily attained by constructing the U-shaped spring 204 with the arms being asymmetrically dimensioned, in effect, of different lengths thereby producing a resonant asymmetric scan element. Thus, in a specific embodiment, the arm 208 may be shorter than the arm 206 by a ratio of at least 2: 1. Thus, an asymmetrically dimensioned U-shaped spring will result in a longer X direction scan line in a raster-type pattern.

In addition to increasing the angular amplitude, which can be as much as a 100% increase over a symmetrically dimensioned U-shaped spring, an asymmetrically dimensioned U-shaped spring provides a higher durability against metal fatigue and cracking since the nodal point is no longer located at a curved portion of the spring. This type of construction also provides the benefit of less vibration being transferred to the base, since the U-shaped spring is held only at the magnet end and the angular movement of the magnet can be a plurality of times lower than that of the scanning component or mirror 210.

The foregoing, as exemplified in Figs. 3 and 4 disclosing current technological developments with respect to a scanning arrangement of the type mentioned hereinabove employing either a symmetrical U-shaped spring, as shown in Fig. 3, or an asymmetrically dimensioned U-shaped spring, i.e. with arms of unequal lengths, as shown in Fig. 4, are still subject to various disadvantages which the present invention clearly overcomes.

In the evolution of the inventive scanning arrangement from those in the prior art structures, as shown in Figs. 3 and 4, into that pursuant to the invention, as shown in Figs. 5a and 5b, Fig. 3 illustrates the typical tuning fork whereby the U-shaped spring 300 has arm portions 302 and 304 of equal lengths, in which the free end of the arm 302 mounts the permanent magnet 306, whereas the opposite arm 304 has the free end thereof supporting the scanning element or mirror 308 at generally the center of the latter. Consequently, the distance r represents that from the center of mass of the mirror to the fast axis of rotation; in essence, about the high-frequency axis of rotation thereof, with the mirror size, the latter being relatively uniform in surface dimensions being represented by l. Consequently, the stress which is generated in the flexure, in effect, the U-shaped spring 300 of the scanning device at the locale of the attachment of the scan element or mirror 308, defined by the U-shaped spring 300 is represented by essentially the following equation:

$$S = \frac{6}{wt^2} = \bullet\ \alpha \bullet (2\ \pi f)^2 \bullet M(\frac{l^2}{12}+r^2)$$

wherein:

- S = stress in holder (flexure or spring)
- w = the width of the flexure and (width of the U-shaped spring 300)
- t = the thickness of the flexure (spring 300)
- α = angle of maximum deflection (of mirror)
- f = frequency of vibration
- M = mass of mirror
- l = size of mirror (surface area)
- r = distance from the center of mass of the mirror to the fast axis of rotation.

From the foregoing, it appears that a factor which considerably controls the stress level in the flexure is primarily represented by the distance r between the center of mass of the mirror or scan element 308 and the fast or high-frequency axis of rotation for the flexure or U-shaped spring 300.

In Fig. 4, which schematically represents the mirror-holding components and asymmetrically U-shaped spring 204 as shown in Fig. 2, the utilization of the asymmetrical U-shaped spring 204, having the arm 208 thereof considerably shorter than the arm 206, the distance r between the center of mass of the mirror and the fast axis of rotation, as is clearly ascertainable, is considerably shorter for this embodiment of a resonance asymmetric scan element in comparison with that in Fig. 3. Consequently, the stress S generated in the flexure

or the U-shaped spring 204 is reduced by the function in the differential between "r^2", (r to the second power) in essence, by a considerable amount in comparison with that encountered in the embodiment of Fig. 3 illustrating a U-shaped spring having arms of equal lengths.

However, the level of stress s encountered in the flexures or U-shaped springs during scanning operation at the location of attachment of the mirror, as evidenced by the foregoing values of r when computed in the equation as set forth hereinabove may be still further extensively reduced and optimized by mounting the mirror on the holder and also designing the configuration of the former in such a manner as to produce an arrangement in which the center of mass of the mirror and the fast axis of rotation, in effect the high-frequency oscillating axis for the mirror substantially coincide so as to thereby reduce the value of r to essentially zero in the equation. This value of zero for r when introduced into the stress equation for the flexure or spring as set forth hereinabove, provides a significant reduction in the level of stress to which the flexure represented by the U-shaped spring is subjected during the oscillations of the scanning element or mirror.

In accordance with the present invention, this advantage of reducing the stress s to an optimum reduced level may be readily attained with a large-sized scan element or mirror of novel configuration which is clampingly mounted in a suitable holding structure having flexible clip-like gripping arms formed at the end of the shorter arm of the U-shaped spring supporting the scan mirror.

Having specific reference to Figs. 5a, 5b, 6 and 7, the scanning arrangement 400 pursuant to the invention comprises a resonance asymmetric scan element including a flexure consisting of a U-shaped spring 402 which has a first arm 406 into which there is fastened a magnet 408, whereas a second arm 410 of the U-shaped spring or flexure 404 which is shorter than the arm 406 has its upper or free end provided with a flexible holder structure 412, preferably constituted from a beryllium-cooper alloy, as described in more specific detail hereinbelow, for clampingly engaging and mounting a scan element or mirror 414 which is constructed according to the present invention. Hereby, the mirror has a reduced cross-sectional width at the upper end 416 thereof so as to form a generally rectangular neck portion 418, the opposite side edges 418a, 418b of which are clamped by inwardly folded clip-like members or gripping arms 420 and 422 formed at the opposite sides of the holder structure 412 on the upper end of the arm 410. Below the neck portion 418 of the mirror 414, which is mounted on the spring arm 410 by being engaged and between the gripping arms 420, 422, the mirror widens considerably both sideways and downwardly so as to provide a large surface 424 for scanning purposes, through which there extends the fast or high-frequency axis of rotation 426. This mounting of the mirror 414 at its upper neck portion 418 to the flexure or spring 404 essentially positions the center of mass M of the mirror 414 so as to essentially coincide with the fast axis of rotation 426 and thereby reduces the distance r between the mirror center of mass and the axis of rotation to practically zero.

The upper end of the spring arm 410 with the gripping arms 420, 422 on the holder structure 412, as may be more closely ascertained from Figs. 6 and 7 of the drawings, discloses that the flexible gripping arms 420 and 422 are each provided at their lower ends with ear lobes 430 or recesses so as to render them more resilient or flexible towards those ends from which the mirror neck portion 418 is inserted into surface contact with the holder structure 412 of the flexure or U-shaped spring 404. Thus, as shown in Fig. 7, upon the mirror being slid beneath the gripping arms 420 and 422 until the upper wider edge of the shoulder 432 contact the lower edges of ear lobes 430 to enable the fixed yet flexible mounting thereof in the holder structure.

As shown in Figs. 8a through c, upon the insertion of the edges 418a, 418b of the neck portion 418 of the mirror 404 into the respective clip-like gripping arms 420 and 422 upwardly from the ends containing the ear lobes or recesses 430, the latter of which resultingly render the gripping arms 420, 422 more flexible at the lower ends since this removal of material allows for a greater resilient displacement thereof, the radius of the mirror is utilized to provide an improved attachment, with the lateral mirror dimensions within the holder structure 412 being increased while being advanced into the gripping arms. Consequently, as shown in Fig. 9 of the drawings, the mounting of the mirror 414 at the upper neck end 418 between the gripping arms 420, 422 and the configuration of the mirror surface enables the coincidence in positioning between the fast axis of rotation 426 for the high-frequency oscillation of the mirror and the center of mass M of the mirror, thereby extensively reducing any generated stresses and imparting an enhanced service life expectancy to the resonant asymmetric scan element. This resultingly maximizes the efficiency in the operation of the scan element and it is possible to attain higher frequencies during scanning operation at larger amplitudes, while employing a larger-sized mirror in comparison with that employed in the earlier constructions. Hereby, a high-frequency operation of the inventive scan element within the range of 350 of up to 1200 Hz becomes easily possible for large mirror sizes of up to 0.8 in. by 0.8 in., with a low stress which will inhibit any breaking of the scan element under the oscillating weight of the mirror.

Another preferred embodiment of the invention, as illustrated is Figures 10 to 13 of the drawings. In this particular embodiment of the scanning arrangement 500, the scanning element or mirror 502 is essentially of a configuration similar to that of the mirror 414 in Figures 5 through 9. However, in this construction of the scanning arrangement 500, a wider flexure is employed for the low-frequency flexure or U-shaped spring 504

mounting the mirror 502 so as to be able to operate at lower frequencies, such as within the range of about 5 to 10 Hz. In this instance, a support plate 506 has the plate 506 has the free end of arm 508 of the U-shaped spring 504 fastened thereto, with the mirror 502 being fastened to the other arm 510 through the intermediary of a holder 512 which is, essentially, similar to holder structure 412 as shown in Fig.s 6 through 9 of the drawings. The end of spring arm 508 and support plate 506 have the permanent magnet 514 fastened thereto so as to extend from the rear surface of plate 506 to be reciprocatably engageable into an electromagnetic coil 516 adapted to be supplied with an energizing signal through electrical input leads 518.

As shown in the drawings, in this embodiment the U-shaped spring 504 is rotated or angled by about 90° relative to the extent or axial length of a preferably plate-like or flat high-frequency spring 520 which, if desired, may be constituted from Mylar or the like, which is fastened to a lower bent portion 522 and connection 524 to the plate 506. The portions 522 and 524 of the spring 520 may be beryllium-copper, as also may be the case for U-shaped spring 504. The Mylar material for the high-frequency spring 520 may be fastened by means of suitable screw fasteners 526 so as to be clampingly engaged intermediate its ends between a support frame 528 for the operative components (not shown) of the scanner and a support structure 530 for the electromagnetic coil 516, so as to be modularly installable in a housing of the scanner; such as shown in Fig. 1.

Hereby, the novel configuration of this embodiment of the scanning arrangement not only allows for operation at extremely low scanning frequencies, as mentioned hereinabove, but also provides for an improved isolation from encountered vibrations by the scanning arrangement.

Claims

1. A scanner for reading indicia (170) having portions of differing light reflectivity by directing light (151) from said scanner towards said indicia (170) and by collecting reflected light (152) returning from said indicia (170); said scanner comprising an arrangement (200;400;500) for scanning the indicia (170), comprising:

   (a) a scanner component (210; 414; 502);
   (b) holder means mounting said scanner component (210;414;502) for angular oscillating movement in first and second scan directions between first and second pairs of scan end positions, said holder means including first and second vibratory means (204,222;404; 504,520) positioned to vibrate in two orthogonal planes and to cooperate for angular oscillating movement in first and second orthogonal scan directions about respective axes for fast and slow oscillatory rotation of said scanner component (210;414;502), and
   (c) read-start means for simultaneously moving said scanner component (210;414;502) in said first and second scan directions to simultaneously angularly oscillate said scanner component between said first and second pair of scan end positions for directing the light along said first and second scan directions so as to resultingly implement a two-dimensional scan pattern over the indicia (170);

   characterised in that said scanner component is configured and is mounted on said holder means such that the center of mass of said component coincides with the fast axis (426) of oscillatory rotation of said scanner component on said holder means.

2. The scanner as claimed in Claim 1, wherein said read-start means moves said scanner component (210;414;502) in scan directions to resultingly implement a raster scan pattern over the indicia (170).

3. The scanner as claimed in Claim 1, wherein said read-start means moves said scanner component (210;414;502) in scan directions to resultingly implement an omnidirectional scan pattern over the indicia (170).

4. The scanner as claimed in Claim 1, wherein said first vibratory means comprises a U-shaped spring (204;404;504) having a pair of arms, said scanner component (210;414;502) being mounted at the free end of one of said arms.

5. The scanner as claimed in Claim 4, wherein said second vibratory means comprises a generally planar spring (222;520) having one end secured to the end of the other arm of said U-shaped spring (204; 502) and the other end secured to a base.

6. The scanner as claimed in Claim 5, wherein said read-start means includes an electrically-operated actuator responsive to actuation thereof for vibrating said holder means to angularly oscillate said component (210;414;502) in the first and second scan directions, said actuator including an electromagnetic coil (214;516) having a passage, and a magnet (212;408;514) mounted on the holder means and movable into and out of the passage during actuation of said coil (214;516).

7. The scanner as claimed in Claim 6, wherein said magnet (212) is mounted on said holder means proximate the juncture between said other end of the planar spring (222) and said other arm of said U-shaped (204) spring.

8. The scanner as claimed in Claim 6, wherein said first vibratory means is configured to vibrate at a high range of frequencies and wherein said second vibratory means is configured to vibrate at a low range of frequencies to thereby effect a raster-type scan pattern over the indicia (170) in response to a driving signal applied to said coil (214;516) comprising a superposition of a first signal having a frequency within said high range and a second signal having a frequency within said low range.

9. The scanner as claimed in Claim 4, wherein the arms of said U-shaped spring (204;404;504) are asymmetrically dimensioned.

10. The arrangement as claimed in Claim 6, wherein the center of mass of said scanner component is offset from the axis formed by the electromagnetic coil (214;516) and said magnet (212;408;514).

11. The scanner as claimed in Claim 10, wherein the offset center of mass of said scanner component provides a restoring force to torsionally vibrate said planar spring (520) along the first scan direction at a high range of frequencies, and said U-shaped spring (504) vibrates along the second scan direction at a low range of frequencies to effect a raster-type scan over the indicia (170) in response to a superimposed high and low frequency driving signal.

12. The scanner as claimed in Claim 5, wherein said U-shaped spring (204;404;504) is formed from a bent leaf spring.

13. The scanner as claimed in Claim 1, wherein said scanner component (210;414;502) scans said indicia (170) at frequencies within the range of about 150 to 1200 Hz.

14. The scanner as claimed in Claim 1, wherein said indicia (170) is a bar code symbol and said scanner is a bar code reader (100).

15. The scanner as claimed in Claim 4, wherein the holder means on said arm of said vibratory means mounting said scanner component comprises inwardly folded flexible clip means (420;422) on opposite side edges of said arm, said scanner component (414) having a neck portion (418) of reduced width at one end thereof grippingly engaged between said respective folded clip means (420,422) so as to be resiliently mounted on said arm.

16. The scanner as claimed in Claim 15, wherein said folded clip means (420,422) each have earlobes (430) at a low end thereof receiving the neck portion (418) of said scanner component (414) so as to increase the degree of flexibility in the mounting of said component.

17. The scanner as claimed in Claim 16, wherein said scanner component (414) comprises a scan mirror having a convexly-curved rear surface and a neck portion (418) of narrower width having side edges insertable between said folded clip means (420,422) whereby advancing said mirror into said holder means causes said clip means (420,422) to enhance gripping engagement therewith through the imparting of a curvature to the surface portion on said arm extending therebetween in conformance with the curvature of said scan mirror.

18. The scanner as claimed in Claim 15, wherein at least said folded clip means (420,422) and scanner component mounting means are constituted from a non-ferrous alloy.

19. The scanner as claimed in claim 18, wherein said non-ferrous alloy comprises a beryllium-copper alloy.

Patentansprüche

1. Abtastvorrichtung zum Lesen von Anzeigemitteln (170), die Teile unterschiedlicher Lichtreflektivität besitzten, und zwar durch Richten von Licht (151) von der Abtastvorrichtung zu den Anzeigemitteln (170) hin und durch Sammeln des von den Anzeigemitteln (170) zurückkehrenden reflektierten Lichtes (152), wobei die Abtastvorrichtung eine Anordnung (200; 400; 500) aufweist zum Abtasten der Anzeigemittel (170), die folgendes aufweist:

   (a) eine Abtastkomponente (210; 414; 502);
   (b) Haltemittel zum Befestigen der Abtastkomponente (210; 414; 502) zur winkelmäßigen Schwingbewegung in ersten und zweiten Abtastrichtungen zwischen ersten und zweiten Paaren von Abtastendpositionen, wobei die Haltemittel erste und zweite Schwingmittel (204; 222; 404; 504; 520) aufweisen, und zwar positioniert zur Schwingung oder Vibration in zwei orthogonalen Ebenen und zur Zusammenarbeit zur winkelmäßigen Schwing- oder Oszillationsbewegung in ersten und zweiten orthogonalen Abtastrichtungen um entsprechende Achsen für schnelle und langsame oszillatorische Drehung der erwähnten Abtastkomponente (210; 414; 502); und
   (c) Lesestartmittel zum simultanen Bewegen der Abtastkomponente (210; 414; 502) in den erwähnten ersten und zweiten Abtastrichtungen, um simultan die erwähnte Abtastkomponente winkelmäßig zwischen den erwähnten

ersten und zweiten Paaren von Abtastendpositionen zu oszillieren, und zwar zur Leitung des Lichtes entlang der ersten und zweiten Abtastrichtungen, um so resultierend ein zweidimensionales Abtastmuster über den Anzeigemitteln (170) zu implementieren;

dadurch gekennzeichnet, daß die erwähnte Abtastkomponente derart konfiguriert und an den Haltemitteln angebracht ist, daß der Massenmittelpunkt der Komponente mit der Achse (426) der schnellen oszillatorischen Rotation der erwähnten Abtastkomponente an den Haltemitteln zusammenfällt.

2. Abtastvorrichtung nach Anspruch 1, wobei die erwähnten Lesestartmittel die Abtastkomponente (210; 414; 502) in Abtastrichtungen bewegen, um in resultierender Weise ein Rasterabtastmuster über den Anzeigemitteln (170) zu implementieren.

3. Abtastvorrichtung nach Anspruch 1, wobei die erwähnten Lesestartmittel die Abtastkomponente (210; 414; 502) in Abtastrichtungen bewegen, um in resultierender Weise ein Allrichtungsabtastmuster über den Anzeigemitteln (170) zu implementieren.

4. Abtastvorrichtung nach Anspruch 1, wobei die ersten Schwing- oder Vibrationsmittel eine U-förmige Feder (204; 404; 504) aufweisen mit einem Paar von Armen, und wobei die Abtastkomponente (210; 414; 502) an dem freien Ende eines der Arme angebracht ist.

5. Abtastvorrichtung nach Anspruch 4, wobei die zweiten Vibrations- oder Schwingmittel eine im ganzen planare oder ebene Feder (222; 520) aufweisen, die mit einem Ende an dem Ende des anderen Arms der erwähnten U-förmigen Feder (204; 502) und mit dem anderen Ende an einer Basis befestigt ist.

6. Abtastvorrichtung nach Anspruch 5, wobei die Lesestartmittel einen elektrisch betätigten Betätiger aufweisen, der auf die Betätigung anspricht zum Zwecke der Vibration oder Schwingung der Haltemittel, um die Komponente (210; 414; 502) in den ersten und zweiten Abtastrichtungen winkelmäßig zu oszillieren, wobei der Betätiger eine elektromagnetische Spule (214; 516) aufweist mit einem Durchlaß, und wobei ein Magnet (212; 408; 514) an den Haltemitteln befestigt und in und aus dem Durchlaß heraus während der Betätigung der Spule (214; 516) bewegbar ist.

7. Abtastvorrichtung nach Anspruch 6, wobei der Magnet (212) an den Haltemitteln angebracht ist, und zwar nahe zwischen der Verbindung zwischen dem erwähnten anderen Ende der Planarfeder (222) und dem erwähnten anderen Arm der U-förmigen Feder (204).

8. Abtastvorrichtung nach Anspruch 6, wobei die ersten Schwing- oder Vibrationsmittel derart konfiguriert sind, um mit einem hohen Bereich von Frequenzen zu vibrieren oder schwingen, und wobei die zweiten Vibrations- oder Schwingmittel derart konfiguriert sind, um in einem niedrigen Bereich von Frequenzen zu vibrieren oder zu schwingen, um dadurch ein rasterartiges Abtastmuster über den Anzeigemitteln (170) zu bewirken, und zwar ansprechend auf ein Treibersignal, angelegt an die Spule (214; 516), wobei dieses eine Überlagerung eines ersten Signals mit einer Frequenz innerhalb des erwähnten hohen Bereichs und eines zweiten Signals mit einer Frequenz innerhalb des erwähnten niedrigen Bereichs aufweist.

9. Abtastvorrichtung nach Anspruch 4, wobei die Arme der U-förmigen Feder (204; 404; 504) asymmetrisch dimensioniert sind.

10. Anordnung nach Anspruch 6, wobei der Massenmittelpunkt der Abtastkomponente gegenüber der Achse versetzt ist, die durch die elektromagnetische Spule (214; 516) und den Magnet (212; 408; 514) gebildet ist.

11. Abtastvorrichtung nach Anspruch 10, wobei der versetzte Massenmittelpunkt der Abtastkomponente eine Rückholkraft vorsieht, um die erwähnte Planarfeder (520) entlang der ersten Abtastrichtung mit einem hohen Bereich von Frequenzen torsionsmäßig zu vibrieren oder zu schwingen, und wobei die U-förmige Feder (504) entlang der zweiten Abtastrichtung mit einem niedrigen Bereich von Frequenzen vibriert oder schwingt, um eine rasterartige Abtastung über den Anzeigemitteln (170) zu bewirken, und zwar infolge eines überlagerten Hoch- und Nieder-Frequenztreibersignals.

12. Abtastvorrichtung nach Anspruch 5, wobei die U-förmige Feder (204; 404; 504) aus einer gebogenen Blattfeder gebildet ist.

13. Abtastvorrichtung nach Anspruch 1, wobei die Abtastkomponente (210; 414; 502) die Anzeigemittel (170) mit Frequenzen innerhalb des Bereichs von ungefähr 150 bis 1200 Hz abtastet.

14. Abtastvorrichtung nach Anspruch 1, wobei die Anzeigemittel (170) ein Strichcodesymbol sind, und wobei die Abtastvorrichtung ein Strichcodeleser (100) ist.

15. Abtastvorrichtung nach Anspruch 4, wobei die Haltemittel an dem erwähnten Arm der Schwing- oder Vibrationsmittel, die die Abtastkomponente anbringen, nach innen gefaltete oder umgebogene flexible Clipmittel (420; 422) auf entgegengesetzen Seitenkanten des Arms aufweisen, wobei die Abtastkomponente (414) einen Halsteil (418) von verminderter Breite an einem Ende davon aufweisen, und zwar ergreifend erfaßt zwischen den erwähnten entsprechenden gefalteten Clipmitteln (420; 422), um so elastisch am Arm angebracht zu sein.

16. Abtastvorrichtung nach Anspruch 15, wobei die erwähnten gefalteten Clipmittel (420; 422) jedes Ohrlappen (430) am unteren Ende davon aufweisen, und zwar zum Aufnehmen des Halsteils (418) der Abtastkomponente (414), um so das Flexibilitätsausmaß bei der Befestigung der Komponente zu vergrößern.

17. Abtastvorrichtung nach Anspruch 16, wobei die erwähnte Abtastkomponente (414) einen Abtastspiegel aufweist mit einer konvex gekrümmten Rückoberfläche und einem Halsteil (418) von schmälerer Breite mit Seitenkanten, einsetzbar zwischen den erwähnten gefalteten Clipmitteln (420; 422), wodurch der Vorschub des erwähnten Spiegels in die erwähnten Haltemittel bewirkt, daß die Clipmittel (420; 422) den Greifeingriff damit vergrößern, und zwar durch Aufprägen einer Krümmung auf den Oberflächenteil an dem erwähnten Arm, der sich dazwischen erstreckt, und zwar entsprechend der Krümmung des Abtastspiegels.

18. Abtastvorrichtung nach Anspruch 15, wobei mindestens die erwähnten gefalteten oder umgelegten Clipmittel (420; 422) und die Befestigungsmittel der Abtastkomponente aus einer nicht-eisenhaltigen Legierung gebildet sind.

19. Abtastvorrichtung nach Anspruch 18, wobei die nicht-eisenhaltige Legierung eine Beryllium-Kupfer-Legierung ist oder eine solche enthält.

Revendications

1. Lecteur optique pour lire des symboles (170) ayant des parties de réflectivités optiques différentes en dirigeant une lumière (151) dudit lecteur optique vers lesdits signes (170) et en recueillant la lumière réfléchie (152) renvoyée par lesdits signes (170) ; ledit lecteur optique comprenant un dispositif (200 ; 400 ; 500) pour lire par balayage les signes (170), comprenant :

(a) un composant de lecture optique (210 414 ; 502) ;

(b) des moyens de support sur lesquels est monté ledit composant de lecture optique (210 ; 414 ; 502) pour effectuer un mouvement d'oscillation angulaire dans des première et seconde directions de balayage entre des première et seconde paires de positions de fin de balayage, lesdits moyens de support comportant des premier et second moyens vibratoires (204, 222 ; 404 ; 504, 520) positionnés de façon à vibrer dans deux plans orthogonaux et à coopérer pour effectuer un mouvement d'oscillation angulaire dans des première et seconde directions de balayage orthogonales par rapport à des axes respectifs afin de produire une rotation oscillatoire rapide et lente dudit composant de lecture optique (210 ; 414 ; 502), et

(c) des moyens de début de lecture pour déplacer simultanément ledit composant de lecture optique (210 ; 414 ; 502) dans lesdites première et seconde directions de balayage afin de faire osciller angulairement simultanément ledit composant de lecture optique entre lesdites première et seconde paires de positions de fin de balayage pour diriger la lumière suivant lesdites première et seconde directions de balayage de façon à produire par conséquent un motif de balayage bidimensionnel sur les signes (170) ;

caractérisé en ce que ledit composant de lecture optique est configuré et est monté sur lesdits moyens de support de façon que le centre de masse dudit composant coïncide avec l'axe rapide (426) de la rotation oscillatoire dudit composant de lecture optique sur lesdits moyens de support.

2. Lecteur optique selon la revendication 1, dans lequel lesdits moyens de début de lecture déplacent ledit composant de lecture optique (210 ; 414 ; 502) dans des directions de balayage conduisant à créer par conséquent un motif de balayage récurrent sur les signes (170).

3. Lecteur optique selon la revendication 1, dans lequel lesdits moyens de début de lecture déplacent ledit composant de lecture optique (210 ; 414 ; 502) dans des directions de balayage conduisant à créer par conséquent un motif de balayage omnidirectionnel sur les signes (170).

4. Lecteur optique selon la revendication 1, dans lequel lesdits premiers moyens vibratoires comprennent un ressort en forme de U (204 ; 404 ; 504) ayant une paire de bras, ledit composant de lecture optique (210 ; 414 502) étant monté à l'extrémité libre de l'un desdits bras.

5. Lecteur optique selon la revendication 4, dans lequel lesdits seconds moyens vibratoires comprennent un ressort globalement plan (222 ; 520) ayant une extrémité fixée à l'extrémité de l'autre bras dudit ressort en forme de U (204 ; 502) et l'autre extrémité fixée à un socle.

6. Lecteur optique selon la revendication 5, dans lequel lesdits moyens de début de lecture comportent un actionneur fonctionnant électriquement sensible à son actionnement pour faire vibrer lesdits moyens de support afin de faire osciller angulairement ledit composant (210 ; 414 ; 502) dans lesdites première et seconde directions de balayage, ledit actionneur comportant une bobine électromagnétique (214 ; 516) ayant un passage et un aimant (212 ; 408 ; 514) monté sur les moyens de support et mobile de façon à entrer et sortir du passage pendant l'actionnement de ladite bobine (214 ; 516).

7. Lecteur optique selon la revendication 6, dans lequel ledit aimant (212) est monté sur lesdits moyens de support à proximité de la jonction entre ladite autre extrémité du ressort plan (222) et ledit autre bras du ressort en forme de U (204).

8. Lecteur optique selon la revendication 6, dans lequel lesdits premiers moyens vibratoires sont configurés de façon à vibrer dans une gamme de fréquences haute, et dans lequel lesdits seconds moyens vibratoires sont configurés de façon à vibrer dans une gamme de fréquences basse afin de réaliser ainsi un motif de balayage du type récurrent sur les signes (170) en réponse à un signal d'attaque appliqué à ladite bobine (214 ; 516), comprenant la superposition d'un premier signal ayant une fréquence se situant dans ladite gamme haute et un second signal ayant une fréquence se situant dans ladite gamme basse.

9. Lecteur optique selon la revendication 4, dans lequel les bras dudit ressort en forme de U (204 404 ; 504) ont des dimensions asymétriques.

10. Dispositif selon la revendication 6, dans lequel le centre de masse dudit composant de lecture optique est décalé par rapport à l'axe formé par la bobine électromagnétique (214 ; 516) et ledit aimant (212 ; 408 514).

11. Lecteur optique selon la revendication 10, dans lequel le centre de masse décalé dudit composant de lecture optique produit une force de rappel conduisant à faire vibrer en torsion ledit ressort plan (520) suivant la première direction de balayage dans une gamme de fréquences haute, et ledit ressort en forme de U (504) vibre suivant la seconde direction de balayage dans une gamme de fréquences basse, afin de produire un balayage du type récurrent sur les signes (170) en réponse à un signal d'attaque à fréquences haute et basse superposées.

12. Lecteur optique selon la revendication 5, dans lequel le ressort en forme U (204 ; 404 ; 504) est formé d'un ressort à lames recourbé.

13. Lecteur optique selon la revendication 1, dans lequel ledit composant de lecture optique (210 ; 414 ; 502) balaye lesdits signes (170) à des fréquences se situant dans la gamme d'environ 150 à 1200 Hz.

14. Lecteur optique selon la revendication 1, dans lequel les signes (170) sont constitués d'un symbole de code-barre et ledit lecteur optique est un lecteur de code-barre (100).

15. Lecteur optique selon la revendication 4, dans lequel lesdits moyens de support sur ledit bras desdits moyens vibratoires sur lequel est monté ledit composant de lecture optique comprennent un moyen de pincement souple replié vers l'intérieur (420, 422) sur des bords latéraux opposés dudit bras, ledit composant de lecture optique (414) ayant une partie étranglée (418) de largeur réduite à l'une de ses extrémités engagée par préhension entre lesdits moyens de pincement repliés respectifs (420, 422) afin qu'il soit monté de façon élastique sur ledit bras.

16. Lecteur optique selon la revendication 15, dans lequel lesdits moyens de pincement repliés (420, 422) ont chacun des lobes (430) à leur extrémité inférieure recevant la partie étranglée (418) dudit composant de lecture optique (414) de façon à augmenter le degré de liberté dans le montage dudit composant.

17. Lecteur optique selon la revendication 16, dans lequel ledit composant de lecture optique (414) comprend un miroir de balayage ayant une surface arrière incurvée de façon convexe et une partie étranglée (418) de plus faible largeur ayant des bords latéraux pouvant être insérés entre lesdits moyens de pincement repliés (420, 422), de sorte que le fait de faire avancer ledit miroir à l'intérieur desdits moyens de support a pour effet que lesdits moyens de pincement (420, 422) accentuent l'engagement par préhension avec ceux-ci du fait qu'une courbure est conférée à la partie de surface dudit bras qui s'étend entre ceux-ci, en conformité avec la courbure dudit miroir de balayage.

18. Lecteur optique selon la revendication 15 dans lequel lesdits moyens de pincement repliés (420, 422) et lesdits moyens de montage du composant de lecture optique sont constitués d'un alliage non

ferreux.

19. Lecteur optique selon la revendication 18, dans lequel ledit alliage non ferreux comprend un alliage de béryllium-cuivre.

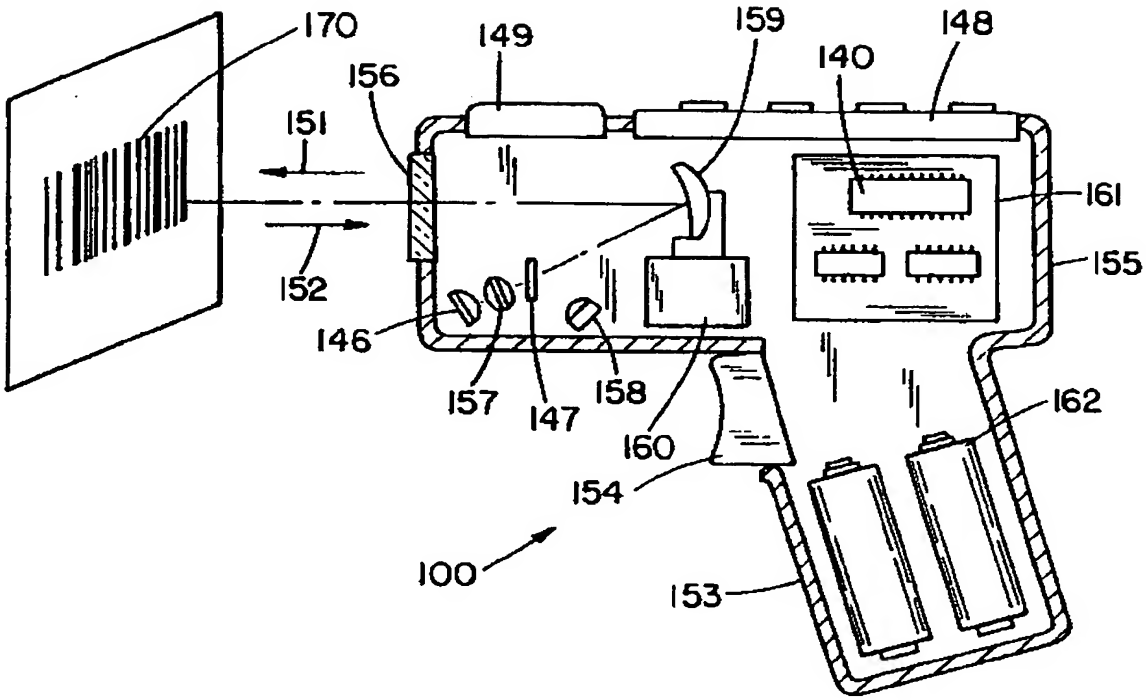
170
149
159
148
140
156
151
161
152
155
146
162
157
147
158
160
154
100
153

FIG. 1

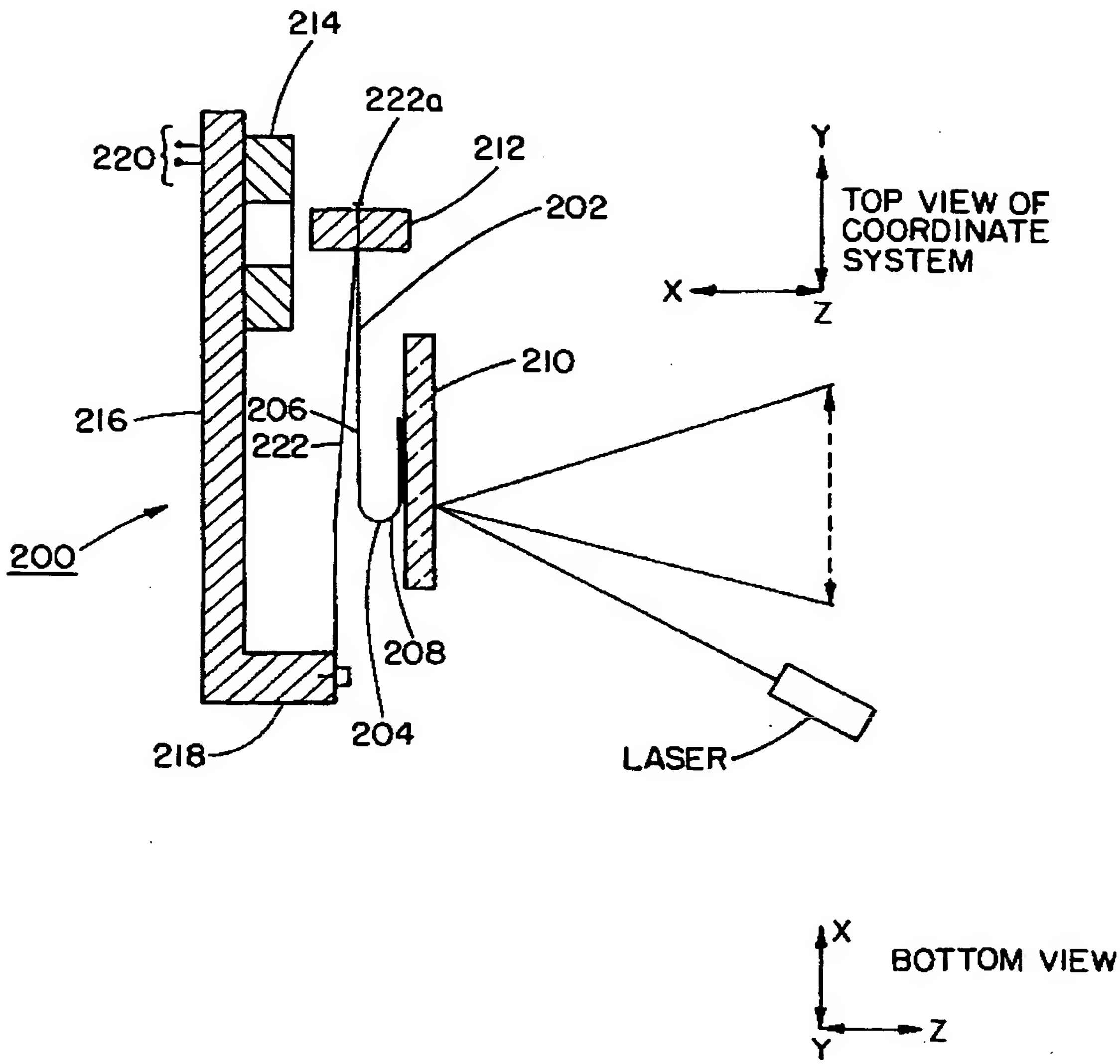
214
222a
212
202
220
TOP VIEW OF
COORDINATE
SYSTEM
Y
X
Z
210
216
206
222
200
208
204
218
LASER
X
BOTTOM VIEW
Y
Z

FIG.2

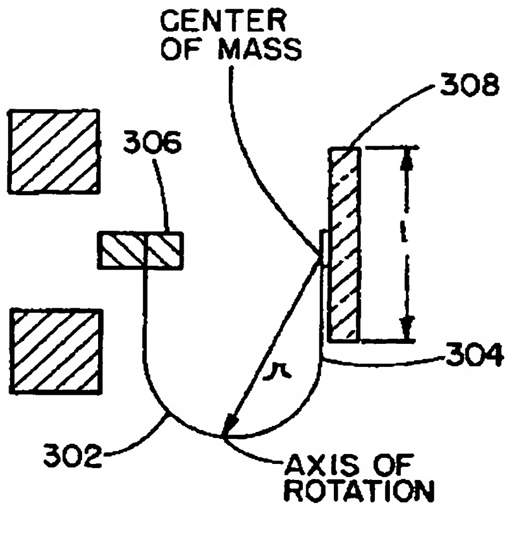

FIG. 3
(PRIOR ART)

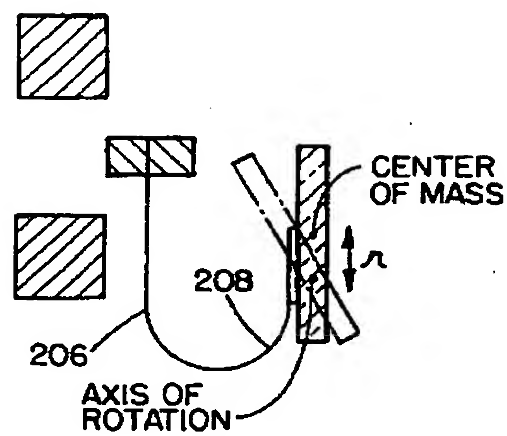

FIG. 4
(PRIOR ART)

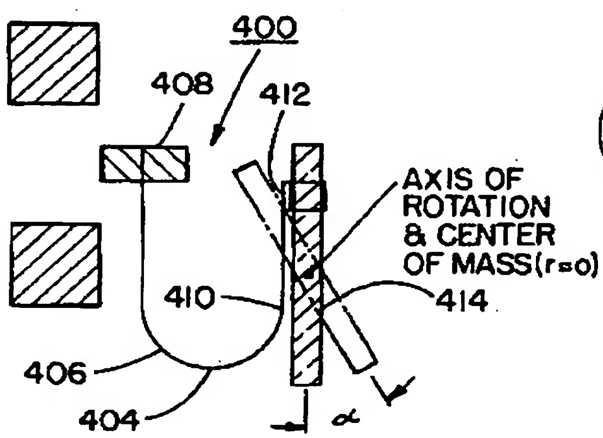

FIG. 5a

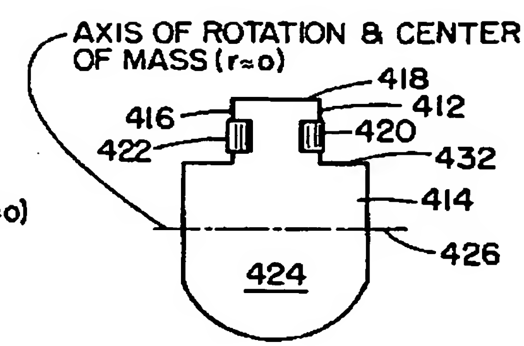

FIG. 5b

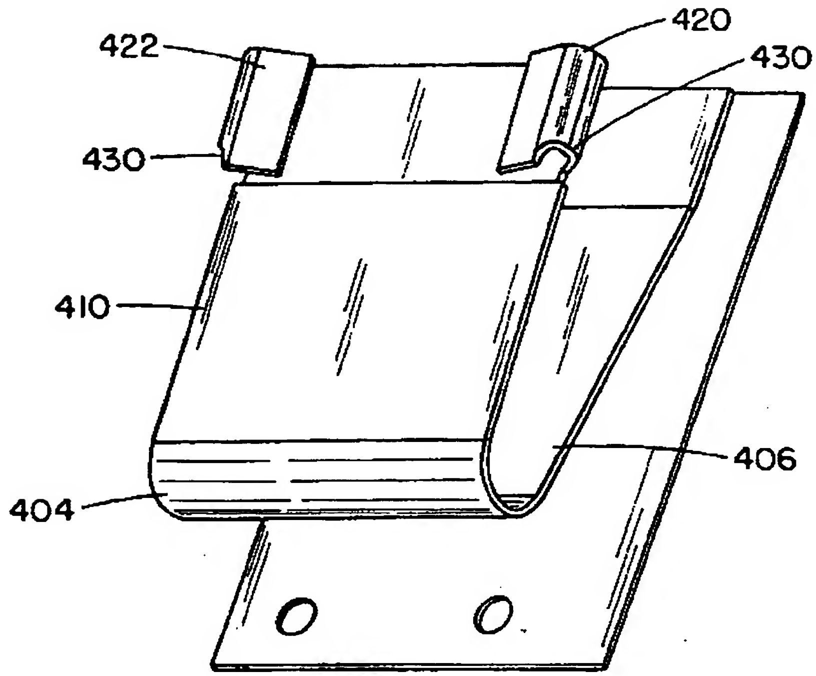
422
420
430
430
410
406
404

FIG.6

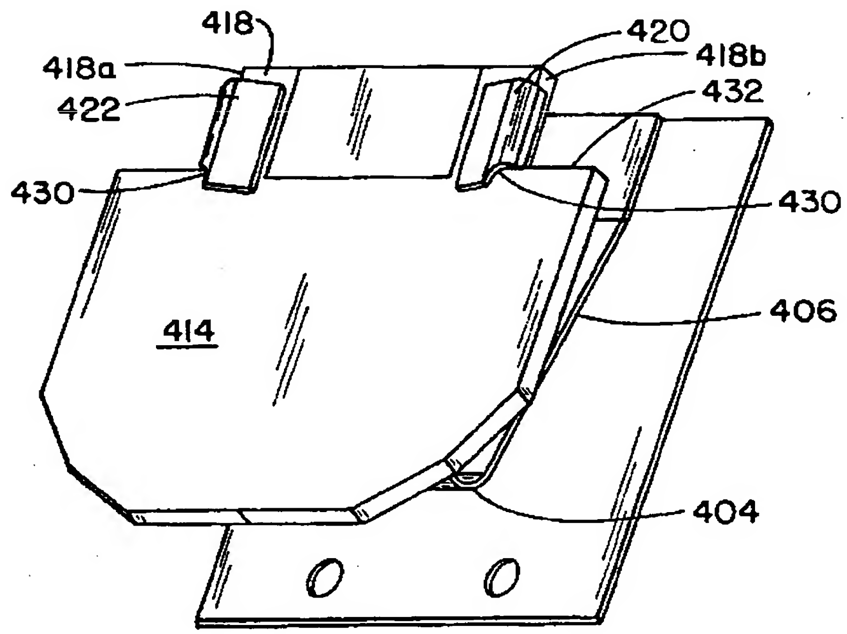
418
420
418a
418b
422
432
430
430
414
406
404

FIG.7

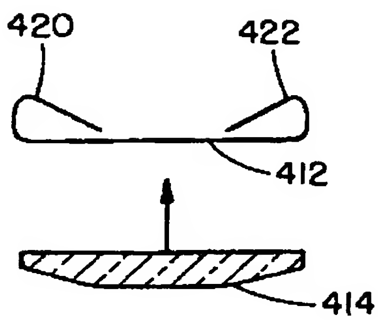

FIG.8a

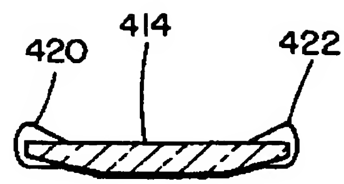

FIG.8b

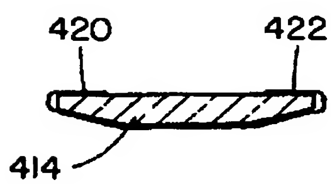

FIG.8c

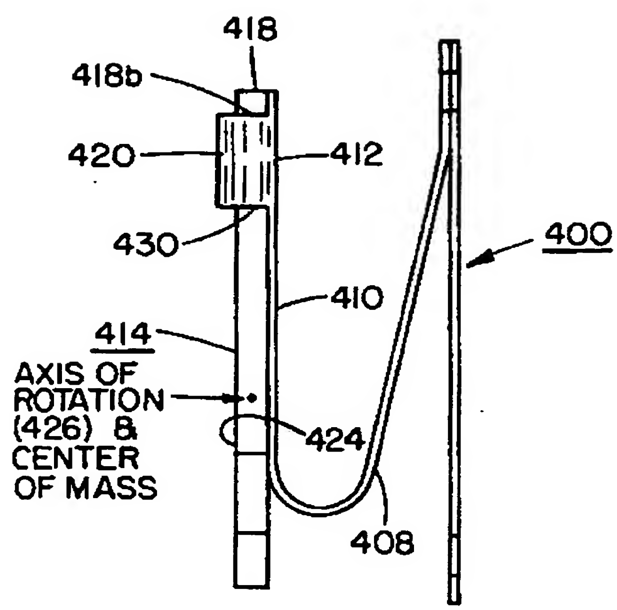

FIG.9

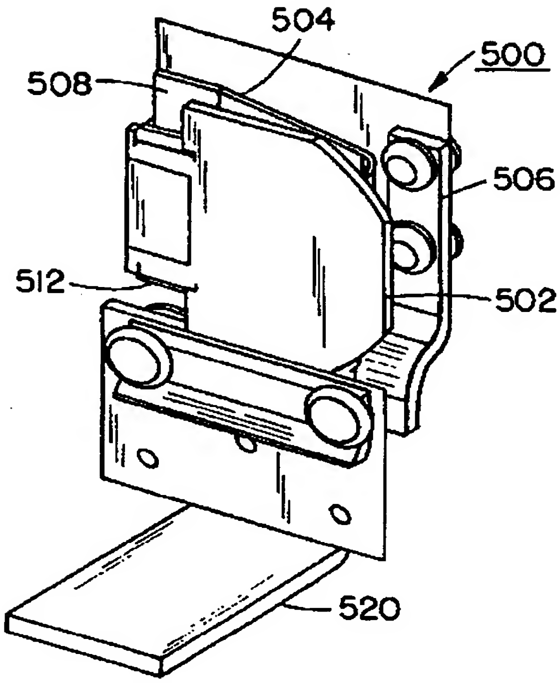

FIG.10

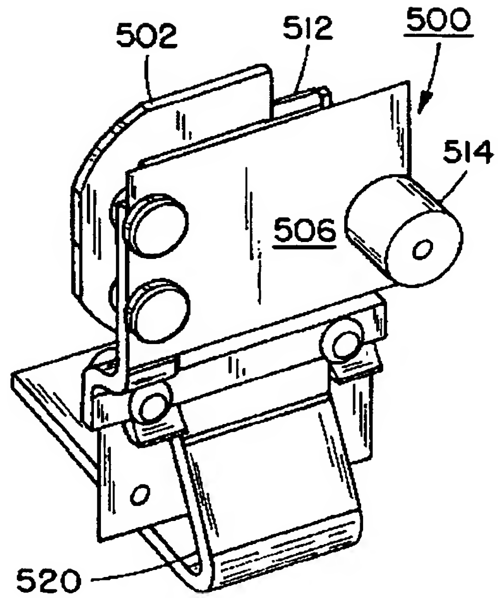

FIG.11

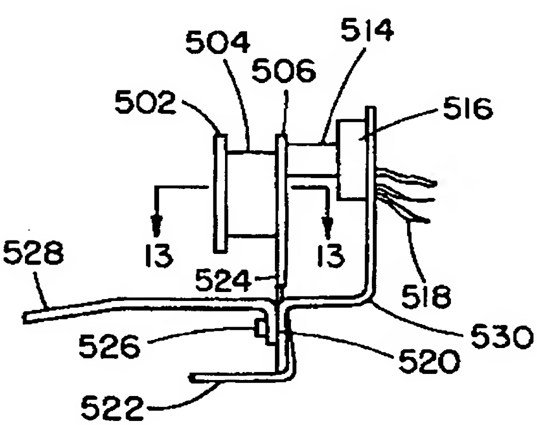

FIG.12

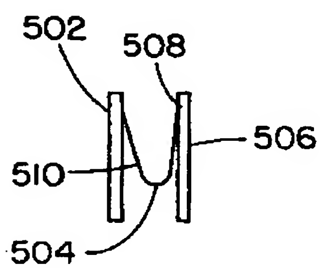

FIG.13